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REPELLENT OR AVERSIVE CHEMICALS IN SHEEP NECK COLLARS DID NOT DETER COYOTE ATTACKS

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ABSTRACT: Since 1974 the Fish and Wildlife Service has studied a "toxic collar" to poison coyotes that attack collared sheep and goats. The collar patent (McBride 1974) indicates that the same collar could deliver chemicals to repel coyotes, thus saving both the coyote and the livestock.

This report summarizes our experience with nonlethal tests of collars. During collar tests with 10 different toxicants, 21 coyotes received sublethal doses followed by aversive behavior or potentially aversive reactions. The subsequent predation history of these coyotes was examined for prey-avoidance. After a sublethal test, all coyotes killed lambs or kids in about 40 days, and 20 of 21 were eventually killed by another toxic collar. Limited testing with coyotes averted to salt flavor by lithium chloride-treated sheep bait also indicated poor protection of live sheep treated externally with salts (NaCl and LiCl). The results indicated little potential for using repellent or aversive chemicals in toxic collars or on sheep to repel coyotes.

INTRODUCTION

Since 1974, the U.S. Fish and Wildlife Service has studied a livestock protection collar or "toxic collar" (McBride 1974) to selectively poison coyotes (*Canis latrans*) that prey on domestic sheep or goats. These studies have concentrated on delivering lethal chemicals to attacking coyotes (Connolly et al. 1978, Connolly 1980, Savarie and Sterner 1979, and Sterner 1979) and the possibility of using the collars to repel coyotes rather than kill them. The toxic-collar patent (McBride 1974) includes repellent use. Lehner (1976) thought that the toxic collar might be more effective if it made coyotes severely ill rather than killing them. He suggested that coyotes might learn to avoid sheep and possibly transmit the "avoid sheep" message to other coyotes. Also, recent issues of the *National Wool Grower* carry advertisements for a neck collar that repels coyotes.

The repellent approach to depredation control would be effective if coyotes refrained from further attacks after puncturing collars with "unpleasant" chemicals or if an effective odor repellent was found. The predation histories of 21 coyotes used in our toxic-collar tests bear directly on the repellent chemical concept. These captive coyotes received sublethal doses of chemicals from collars on live prey and subsequently had the opportunity to kill similar prey. In this paper we examine the predation histories of the surviving coyotes for evidence of prey avoidance after sublethal punctures of toxic collars, and we present results from our work with lithium chloride (LiCl) used as a repellent.

METHODS

Tests were conducted with captive coyotes at the predator research site near Logan, Utah, in field pens that were either 1 ha or 250 m^2 in size. Collared lambs or kid goats were released into pens containing single or paired coyotes. Coyote attack behavior was observed from a building adjacent to the pens and the results were recorded on standardized forms. The coyotes were raised at the research site by humans or by their natural parents and were known livestock killers before the tests began. Between tests coyotes were maintained in kennels, fed commerical mink food, and had water *ad libitum*.

A variety of obviously repellent chemicals[1/] was tested, including several formulations of sodium cyanide (NaCN), and mandelonitrile, 4-aminopyridine (Avitrol®), and phosphamidon. Other chemicals were tested that produced less violent coyote reactions, but that might have caused repellency or learned aversion. These chemicals included: diphacinone and brodifacoum, anticoagulants that produced circulatory system upsets; carbofuran, methomyl, and sodium fluoroacetate that produced neural upsets; PAPP (p-aminopropiophenone) that produced nausea and vomiting; and reserpine that produced lethargy and hypothermia. Cod liver oil, olive oil, and antifreeze were sometimes used as possible coyote attractants in conjunction with the above toxicants or by themselves in collars. New collar designs were also tested during this period, and these collars usually contained a water solution of Rhodamine-B dye.

In limited testing with the aversive chemical LiCl, the same facilities, coyotes, and care regimes were used. Prior to testing with live prey, coyotes were given LiCl-treated baits or carcasses or both. The amount of LiCl varied from 1 g to 6 g per bait in different tests. After the coyotes demonstrated a bait aversion, based upon the salty taste of the baits, they were offered live sheep that either wore a collar filled with a liCl solution, had their necks treated with table salt (NaCl), or were submerged (dipped) in a LiCl solution. The NaCl and LiCl treatments on sheep varied in concentration from a saturated salt solution to 40 g per liter (g/l).

[1/] The use of chemical names does not imply endorsement by the United States Government.

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RESULTS

Twenty-one coyotes at the research site survived at least one puncture of a toxic collar and subsequently had the opportunity to attack more sheep or goats (Table 1). The table includes both coyotes that received sublethal doses of fast-acting chemicals, and coyotes that received lethal doses of slow-acting chemicals (anticoagulants) if they had the opportunity to attack prey while they were still alive and healthy. Coyotes that punctured collars containing aversive and repellent compounds usually let go of the collar as soon as they detected the toxicant. The coyotes shook their heads and rubbed their muzzles on the ground or in snow as if they were attempting to clear the undesirable material from their mouths (Connolly et al. 1978). Coyotes that punctured collars containing slow-acting, or non-detectable chemicals usually demonstrated no observable reaction.

All coyotes subsequently attacked more livestock and 20 of the 21 were eventually killed with toxic collars. The coyote not killed by a toxic collar, coyote 2992, died from treatment in another study. Average time between the chemical dose from a collar and the next prey killed by coyotes was 39 days (SD = 77 days). However, no effort was made to test coyotes soon after they recovered from toxic symptoms, and therefore both the average and standard deviation (SD) are greatly skewed toward longer periods. Most coyotes probably would have attacked lambs much sooner had they been given the opportunity.

In addition to the coyotes shown in Table 1, two others that never punctured collars appeared to avoid them perhaps because the collars were strange, or protected the neck and made prey hard to kill. One of the above two was seven years old and had very worn teeth. Examination of collars after her attacks showed "dents" in the collar, but no punctures. Also, test coyotes that received sublethal doses of NaCN frequently avoided collars and the neck area, but killed sheep with rear-end attacks.

In four tests, coyotes that showed LiCl-induced salt-flavor avoidance of sheep baits, carcasses, or both, were allowed to attack salt-treated live sheep. The subsequent results were: (1) Coyotes Fred and Dizzy attacked a ewe wearing a collar filled with LiCl solution. The collar was not broken. (2 and 3) Coyotes Fred and Rosie, in separate tests, each attacked a lamb with a "mild" NaCl solution on its neck. The coyotes appeared unaffected by the salt treatment. (4) Coyote Fred attacked a lamb with a saturated NaCl solution on its neck. He broke off the attack with head shaking after tasting the salt.

In similar tests using LiCl as the salty repellent on dipped lambs, one coyote killed a lamb dipped in a solution of 20 g LiCl/l H_2O and showed no reaction to the LiCl. On its second test the coyote showed some "dislike" reaction toward the wool after the kill. The lamb was treated with twice as much LiCl (40 g/l) as the first test. The second coyote first showed dislike for LiCl on the wool (20 g/l) and did not kill a dipped lamb. After two days of food deprivation, however, he killed the same lamb with the same LiCl treatment.

In summary, coyotes that received sublethal doses from toxic collars usually did not learn to avoid collars or sheep. Overall, the behavior of treated coyotes did not differ from that of coyotes that punctured collars containing only nontoxic materials (water, olive oil, cod liver oil); they showed no avoidance of sheep and little of collars, e.g., coyote 2648 on 3-31 to 7-30-1976 in Table 1. Coyotes that did learn to avoid collars after puncturing them continued to kill sheep but used different patterns. The results from coyotes averted to salt flavor suggested that they disliked the wool of LiCl-dipped and NaCl-treated lambs, but the dislike was usually not sufficient to prevent them from killing treated sheep.

DISCUSSION

Except with collars containing NaCN, captive coyotes exhibited a remarkable lack of learned avoidance of either livestock or collars after receiving chemicals from the collared prey animals. Coyotes that survived attacks on NcCN collars frequently avoided further or prolonged contact with collars, apparently because of the repellent properties of the chemical (Connolly et al. 1978, Savarie and Sterner 1979) and some learned to avoid collars but continued to kill the collared lambs with throat or rear-end attacks. Hence, even a very strong repellent did not produce prey avoidance.

It should be acknowledged that LiCl was used in few collar tests even though it is commonly employed for aversive conditioning. However, our limited tests with salt on sheep to repel salt-flavor averted coyotes described earlier, and our extensive work with LiCl-induced predation aversion (summarized in Burns 1983a and 1983b) have shown little if any reduction in coyote predation caused by LiCl. Coyotes usually learn to distinguish between LiCl-treated bait material and live prey, and we believe that coyotes would also learn to distinguish between LiCl collars and the prey. Even if coyotes got sufficient LiCl from a collared individual to become ill, we do not expect that they would stop killing livestock.

Though our results with captive coyotes were poor, others have claimed success with repellent sheep collars in the field. Faller (1975) tested a plastic and rubber collar that delivered cinnamic aldehyde to coyotes when punctured. He found a lamb loss to coyote predation of 4.4% in a repellent-collared group compared to 8.2% in a group of uncollared lambs. However, of 27 collared lambs killed by coyotes, only four had collars punctured, and one wonders if the reported difference was not caused by something other than the collars.

Favorable results with a repellent sheep collar have also been reported by a rancher who sells the collars* (Lowry (1983). In a telephone conversation (November 1983) Mr. Lowry reported a significant reduction in coyote predation on sheep when the collars were used. He believes that the collars deter predation for about two months. After about two months, the scent wears off, or coyotes get used to the collars, or both, and coyotes might begin to kill collared sheep.

In conclusion, though there is continuing interest in repelling coyotes from sheep, our observations lead us to believe that employing repellent or aversive chemicals in neck collars would not even stop coyotes from killing collared individuals, much less deter them from uncollared livestock.

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Table 1. Prey-killing performance of captive coyotes after they received sublethal doses of toxicants from toxic neck collars on lambs or kid goats[1/]

Chemical[2/] coyote number, and sex (M or F)	Date	Notes
Sodium monofluoroacetate (1080):		
96 (M)	06-24-82	Sublethal on 1080 neck collar.
	07-06-82	Killed 1080-collared lamb; sublethal on 1080.
	08-02-82	Killed 1080 solid-bait collared lamb; did not eat collar.
	08-10-82	Killed 1080 solid-bait collared lamb; did not eat collar.
	08-16-82	Killed 1080 solid-bait collared lamb; ate collar and died.
Methomyl:		
2583 (F)	06-15-81	Sublethal on low volume methomyl neck collar; showed symptoms.
	09-04-81	Killed and fed on lamb with methomyl and antifreeze neck collar; showed collar avoidance.
	07-06-82	Participated with mate in killing 1080-collared lamb; sublethal on 1080.
	08-02-82	Participated with mate in killing a 1080 solid-bait collared lamb, sublethal on 1080.
	08-10-82	Killed 1080 solid-bait collared lamb; ate collar and died.

(continued on next page)

*Mention of commercial products does not imply endorsement by the United States Government.

Table 1 (continued)

2885 (F)	06-09-81	Sublethal on methomyl neck collar; showed symptoms.
	07-09-81	Probably attacked lamb with antifreeze collar (2 coyotes in pen); sublethal.
	09-09-81	Attacked methomyl-collared lamb; no kill; no puncture.
	05-18-82	Punctured 1080 neck collar and died.
2754 (M)	01-28-81	Sublethal on methomyl neck collar; showed symptoms.
	01-30-81	Killed methomyl-collared lamb; collar not punctured.
	02-17-81	Punctured methomyl neck collar and died.
2703 (M)	11-21-80	Sublethal on methomyl neck collar; showed symptoms.
	01-16-81	Killed methomyl-collared lamb; collar not broken.
	01-21-81	Punctured methomyl neck collar and died.
2990 (F)	09-16-80	Sublethal on methomyl neck collar; showed symptoms.
	09-30-80	Punctured methomyl neck collar and died.
2992 (F)	09-15-80	Sublethal on methomyl neck collar; showed symptoms.
	09-30-80	Attacked methomyl-collared goat with another coyote; collar punctured by other coyote.
	10-17-80	Attacked methomyl-collared goat; collar not broken.
	10-28-80	Sublethal on methomyl-collared goat.
		(Last prey test)
2748 (M)	09-15-80	Sublethal on methomyl neck collar; showed symptoms.
	09-30-80	Punctured methomyl neck collar and died.
<u>P-Aminopropiophenone (PAPP)</u>:		
2811 (M)	12-12-79	Sublethal on PAPP neck collar; showed symptoms.
	12-15-79	Sublethal on PAPP neck collar; showed symptoms.
	03-12-80	Killed uncollared goat (prey choice tests).
	03-17-80	Killed uncollared goat (prey choice tests).
	04-18-80	Killed a brodifacoum-collared goat; collar not broken.
	04-23-80	Killed a brodifacoum-collared goat; slight puncture. Coyote may be avoiding collar, but kills prey.
	05-21-80	Attacked brodifacoum-collared lamb; collar punctured; symptoms not observed.
	05-27-80	Killed an uncollared lamb.
	06-19-80	Killed carbofuran-collared lamb; collar not punctured. Coyote may be avoiding collar, but kills prey.
	06-24-80	Punctured a carbofuran collar and died.
2857 (M)	12-12-79	Sublethal on PAPP neck collar, slight puncture; no symptoms observed. Collar was removed and uncollared lamb was killed that night.
	03-21-80	Killed an uncollared lamb (prey choice tests).
	04-04-80	Killed an uncollared goat (prey choice tests).
	04-23-80	Killed an uncollared goat (prey choice tests).
	05-18-80	Killed carbofuran-collared lamb with another coyote; collar not punctured.
	05-19-80	Killed carbofuran-collared lamb; collar not punctured, may be avoiding collar.
	05-30-80	Punctured carbofuran collar and died.
<u>Diphacinone with reserpine</u>:		
Coty (F) (no number)	01-22-79	Sublethal on diphacinone/reserpine (D-R) collar; reserpine symptoms observed.
	01-28-79	Killed an uncollared lamb.

Table 1 (continued)

	01-29-79	Killed an uncollared lamb.
	02-08-79	Showed symptoms of diphacinone from D-R collar broken on 01-22.
	02-21-79	Punctured a D-R collar and died from reserpine.
<u>Sodium cyanide (NaCN)</u>:		
2616 (M)	01-22-76	Sublethal on NaCN collar; showed symptoms.
	01-26-76	Killed uncollared lamb.
	02-02-76	Received lethal dose from diphacinone collar.
	02-06-76	Killed uncollared lamb.
	02-08-76	Died from drug received on 02-02.
16 (M)	01-27-76	Sublethal on NaCN collar; showed symptoms.
	02-04-76	Punctured a diphacinone collar and died.
39 (M)	01-27-76	Sublethal on NaCN collar.
	02-04-76	Punctured a diphacinone collar and died.
2648 (F)	02-09-76	Sublethal on NaCN collar; showed symptoms.
	03-02-76	Killed diphacinone-collared lamb; collar not broken.
	03-08-76	Sublethal on diphacinone collar; symptoms not observed.
	03-10-76	Killed uncollared lamb.
	03-12-76	Killed uncollared lamb.
	03-16-76	Killed uncollared lamb.
	03-31-76	Killed cod liver oil-collared lamb (no toxicant); collar punctured.
	04-14-76	Killed diphacinone-collared lamb; collar not punctured.
	04-22-76	Killed water-collared lamb (no toxicant) with another coyote; collar punctured.
	04-29-76	Killed olive oil-collared lamb; collar punctured.
	05-03-76	Killed cod liver oil-collared lamb; collar not punctured.
	06-04-76	Killed water-collared lamb; collar not punctured, coyote may be avoiding collar but kills prey.
	06-08-76	Sublethal attack on avitrol collar; showed symptoms.
	07-15-76	Killed new design-collared lamb; collar not broken, coyote may have been avoiding collar but kills prey.
	07-30-76	Punctured a phosphamidon collar and died.
2164 (F)	08-10-76	Sublethal on a NaCN collar; showed symptoms.
	09-02-76	Killed uncollared lamb with other coyotes.
	09-10-76	Sublethal on NaCN collar; showed symptoms.
	12-31-76	Killed water-collared lamb; collar punctured.
	01-14-77	Killed water-collared lamb; collar not punctured.
	02-03-77	Killed water-collared lamb; collar punctured.
	02-09-77	Sublethal attack on a NaCN collar; showed symptoms.
	02-18-77	Killed 1080-collared lamb; collar not punctured.
	04-04-77	Killed 1080-collared lamb; collar not punctured.
	04-13-77	Killed 1080-collared lamb; collar not punctured; may be avoiding collar.
	04-18-77	Punctured 1080-collared lamb and died.
<u>Diphacinone</u>:		
2669 (F)	03-09-76	Received lethal dose from diphacinone collar; no symptoms observed.
	03-10-76	Killed uncollared lamb.
	03-12-76	Killed uncollared lamb.
	03-14-76	Died from drug received on 03-09.

Table 1 (continued)

1896 (M)	03-09-76	Received lethal dose from diphacinone collar; no symptoms observed.
	03-10-76	Killed uncollared lamb.
	03-12-76	Killed uncollared lamb.
	03-14-76	Died from drug received on 03-09.
1898 (M)	03-09-76	Sublethal on a diphacinone collar; no symptoms observed.
	03-10-76	Killed an uncollared lamb.
	03-12-76	Killed an uncollared lamb.
	03-16-76	Killed an uncollared lamb.
	04-01-76	Killed a cod liver oil-collared lamb; collar not punctured.
	04-13-76	Sublethal on diphacinone collar; no symptoms observed.
	04-22-76	Killed water-collared lamb with another coyote; collar punctured.
	05-03-76	Killed water-collared lamb; collar not punctured.
	06-09-76	Punctured an avitrol collar and died.
4-Aminophyridine (Avitrol):		
2196 (F)	06-10-76	Sublethal on avitrol collar; showed symptoms.
	01-24-77	Killed 1080-collared lamb; collar not punctured.
	02-04-77	Killed 1080-collared lamb with another coyote; sublethal on 1080.
	02-16-77	Killed 1080-collared lamb; collar punctured; no symptoms observed.
	02-17-77	Killed 1080-collared lamb; collar punctured; no symptoms observed.
	03-07-77	Punctured a NaCN collar and died.
2160 (F)	06-12-76	Sublethal on avitrol collar; showed symptoms.
	06-17-76	Killed water-collared lamb; collar punctured.
	07-30-76	Punctured phosphamidon collar and died.

1/ Chemical formulations, manufacturers, and collar configurations are detailed in Table 2.

2/ Coyotes are arranged by chemical in first collar punctured; many coyotes later punctured collars containing other chemicals.

Table 2. Chemicals, formulations, and neck collar types for tests shown in Table 1.

Coyote number, sex (M or F), and date[1/]	Toxicant formulation, active ingredients, and collar type
96 (M):	
06-24-82	3 mg 1080[2/]/ml of antifreeze[3/] in 20-30 ml rubber collar.
08-02-82	5 mg 1080/ml H_2O. Solid-bait collars were made of raw sheep hide with the wool trimmed to about 1/4 inch. Melted sheep mesentery fat and corn oil (50-50% mixture) were poured on the wool and solidified. One ml of 1080 solution was poured into a groove made in the surface, and after the water evaporated the 1080-lined groove was filled with melted fat-corn oil and allowed to solidify.
2583 (F):	
06-15-81	200 mg methomyl[4/] /ml H_2O in 12-15 ml rubber collar.
09-04-81	200 mg methomyl/ml antifreeze in 20-30 ml rubber collar.
07-06-82	3 mg 1080/ml of antifreeze in 20-30 ml rubber collar.
08-02-82	5 mg 1080/ml in a solid-bait collar.
2885 (F):	
06-09-81	400 mg methomyl/ml H_2O in 12-15 ml rubber collar.
07-09-81	Antifreeze alone in 20-30 ml rubber collar.

Table 2 (continued)

09-09-81	400 mg methomyl/ml H_2O in 20-30 ml rubber collar.
05-18-82	3 mg 1080/ml antifreeze in 20-30 ml rubber collar.
2754 (M):	
01-28-81	200 mg methomyl/ml H_2O in 20-30 ml rubber collar.
02-17-81	400 mg methomyl/ml H_2O in 20-30 ml rubber collar.
2703 (M):	
11-21-80	200 mg methomyl/ml H_2O ml rubber collar.
2990 (F):	
09-16-80	100 mg methomyl/ml H_2O in 20-30 ml rubber collar.
09-30-80	200 mg methomyl/ml H_2O in 20-30 ml rubber collar.
2992 (F):	
09-15-80	100 mg methomyl/ml H_2O in 20-30 ml rubber collar.
09-30-80	200 mg methomyl/ml H_2O in 20-30 ml rubber collar.
2748 (M):	
09-15-80	100 mg methomyl/ml H_2O in 20-30 ml rubber collar.
09-30-80	200 mg methomyl/ml H_2O in 20-30 ml rubber collar.
2811 (M):	
12-12-79	400 mg PAPP[5/]/ml of .05% carbopol 941[6/] solution in 20-30 ml rubber collar.
04-18-80	20 mg brodifacoum[7/]/ml of .05% carbopol 941 in 20-30 ml collar.
06-19-80	42.4% carbofuran[8/] solution in 20-30 ml rubber collar.
2857 (M):	
12-12-79	400 mg PAPP/ml of .05% carbopol 941 solution in 20-30 ml rubber collar.
05-18-80	42.4% carbofuran solution in 20-30 ml rubber collar.
Coty (F) (no number):	
01-22-79	50 mg diphacinone[9/] and 50 ml reserpine[10/]/ml H_2O in 20-30 ml rubber collar.
2616 (M):	
01-22-76	40-50 ml of 30% NaCN[11/] solution in 4-5 (10 ml each) wool-covered plastic packets.
02-02-76	40 ml of 25 mg/ml diphacinone in .05% carbopol 941 solution in 4 wool-covered plastic packets.
16 (M):	
01-27-76	40-50 ml of 30% NaCN solution in 4-5 (10 ml each) wool-covered plastic packets.
02-04-76	40 ml of 25 mg/ml diphacinone in .05% carbopol 941 solution in 4 wool-covered plastic packets.
39 (M):	
01-27-76	40-50 ml of 30% NaCN solution in 4-5 (10 ml each) wool-covered plastic packets.
02-04-76	40 ml of 25 mg/ml diphacinone in .05% carbopol 941 solution in 4 wool-covered plastic packets.
2648 (F):	
02-09-76	40-50 ml of 30% NaCN solution in 4-5 (10 ml each) wool-covered plastic packets.
03-02-76	40 ml of 12.5 mg/ml diphacinone in .05% carbopol 941 solution in 4 wool-covered plastic packets.
03-08-76	40 ml of 25 mg/ml diphacinone in .05% carbopol 941 solution in 4 wool-covered plastic packets.
06-08-76	50 or 100 mg avitrol[12/]/ml of 80 ml cod liver oil in 4 plastic packets (20 ml each).

Table 2 (continued)

07-15-76	Two 25 ml plastic packets (new design); contents not recorded.
07-30-76	958 mg phosphamidon[13]/ml H_2O in 2 plastic packets (40 ml each).
<u>2164 (F)</u>:	
08-10-76	50 ml of 33% active NaCN gel in two 25 ml plastic packets.
09-10-76	25 ml of 33% active NaCN gel in one 25 ml plastic packet.
02-18-77	3 mg 1080 and .1% rhodamine B[14] dye/ml H_2O in one 40 ml plastic packet.
04-04-77	3 mg 1080 and .1% rhodamine B dye/ml H_2O in two 20-30 ml rubber packets.
<u>2669 (F)</u>:	
03-09-76	40 ml of 12.5 mg/ml diphacinone in .05% carbopol 941 solution in 4 wool-covered plastic packets.
<u>1896 (M)</u>:	
03-09-76	40 ml of 25 mg/ml diphacinone in .05% carbopol 941 solution in 4 wool-covered plastic packets.
<u>1898 (M)</u>:	
03-09-76	40 ml of 25 mg/ml diphacinone in .05% carbopol 941 solution in 4 wool-covered plastic packets.
06-09-76	50 or 100 mg avitrol/ml in 80 ml cod liver oil in 4 plastic packets (20 ml each).
<u>2196 (F)</u>:	
06-10-76	50 or 100 mg avitrol/ml in 80 ml cod liver oil in 4 plastic packets (20 ml each).
01-24-77	1.5 mg 1080/ml H_2O in two 25 ml plastic packets.
02-16-77	4.0 mg 1080 and .1% rhodamine B dye/ml H_2O in two 25 ml plastic packets.
03-07-77	50 ml of 25% active microencapsulated[15] NaCN in cod liver oil in two 25 ml plastic packets.
<u>2160 (F)</u>:	
06-12-76	50 or 100 mg avitrol/ml in 80 ml cod liver oil in 4 plastic packets (20 ml each).
07-30-76	958 mg phosphamidon/ml H_2O in 2 plastic packets (40 ml each).

1/ For dates not shown, the toxicant and formulation were the same as on the previous test for that coyote, or no toxicant was used in the collar.

2/ 1080 (sodium monofluoroacetate), Tull Chemical Co., Inc., Oxford, AL.

3/ Prestone II, Union Carbide Corp., Danbury, CT.

4/ Methomyl, E. I. duPont de Nemours Co., Inc., Wilmington, DE.

5/ PAPP, Eastman Kodak Co., Rochester, NY.

6/ Carbopol 941, B. F. Goodrich Chemical Co., Cleveland, OH.

7/ Brodifacoum, ICI Americas, Wilmington, DE.

8/ Carbofuran, FMC Corp., Jonesboro, AZ.

9/ Diphacinone, Velsicol Chemical Corp., Chicago, IL.

10/ Reserpine, Sigma Chemical Co., St. Louis, MO.

11/ NaCN, Mallinckrodt Inc., St. Louis, MO.
NaCN gels formulated by Southwest Research Inst., San Antonio, TX.

12/ Avitrol (4-aminopyridine), Avitrol Chemical Corp., Tulsa, OK.

13/ Phosphamidon, CIBA-GEIGY Corp., Greensboro, NC.

14/ Rhodamine B dye, Aldrich Chemical Co., Milwaukee, WI.

15/ Microencapsulated by Southwest Research Inst., San Antonio, TX.